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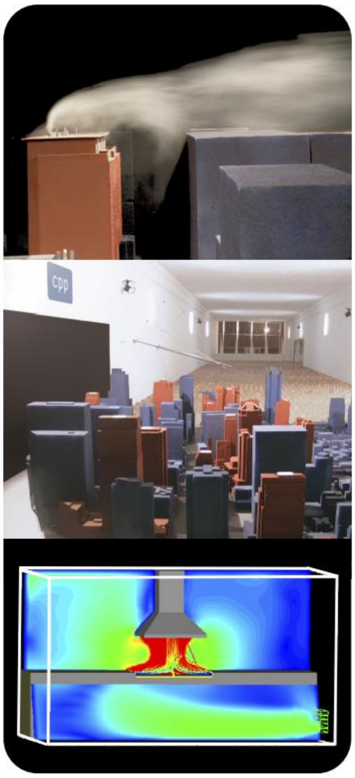
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT



Wind Assessment for:

SYDNEY 1, 1 ALFRED STREET

Sydney, NSW, Australia

Prepared for:

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November 2015

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DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
05/06/15	Initial release for review	GSW	PB	GSW
17/06/15	Minor amendments	GSW	PB	GSW
17/06/15	Final report	GSW	PB	GSW
23/11/15	Revised figures	GSW	GSW	GSW

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Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Wanda to provide an opinion based assessment of the impact of the proposed Sydney 1 development at, 1 Alfred Street, Sydney, on the pedestrian level local wind environment in and around the proposed development. This report qualitatively assesses the pedestrian level wind environment after comparison of the revised geometry to the proposed development with the previous geometry used for the pedestrian level wind-tunnel testing presented in Cermak Peterka Petersen (2010) for the previous development application for this site.

The site is located on the block bounded by Alfred Street, Pitt Street, Crane Place, and George Street. The site is located approximately 100 m from Circular Quay and is surrounded by high rise towers to the south and low to medium rise to the north, Figure 1. The development consists of two towers of varying height and plan form. Comparative images of the existing and proposed designs are presented in Figure 2 and Figure 3. The site is located close to the water line with local topography rising gently to the west and south-east.

Figure 1: Location of the proposed development (Google Earth 2015)

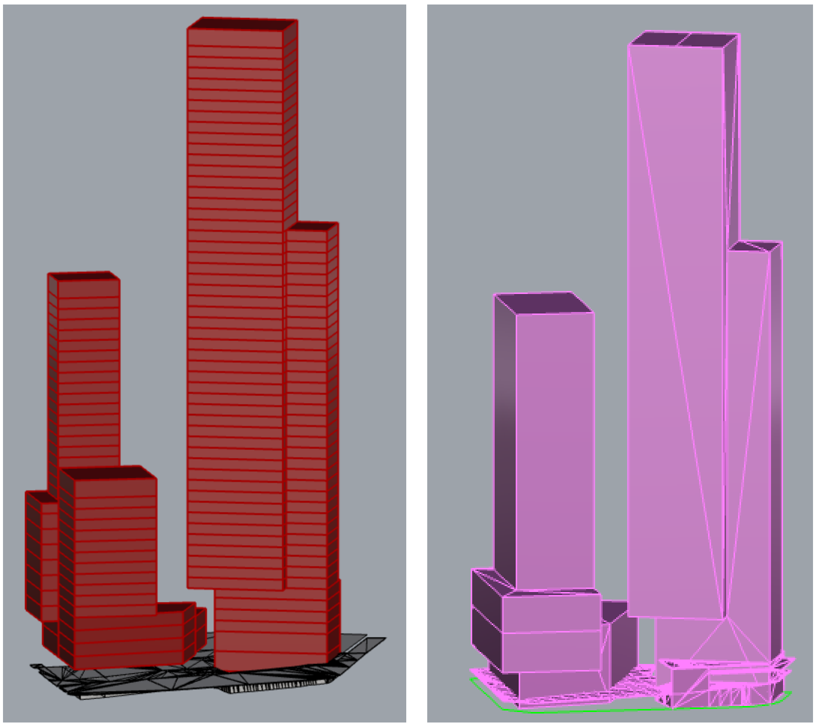

Figure 2: View from the north of existing (L) and proposed (R) development

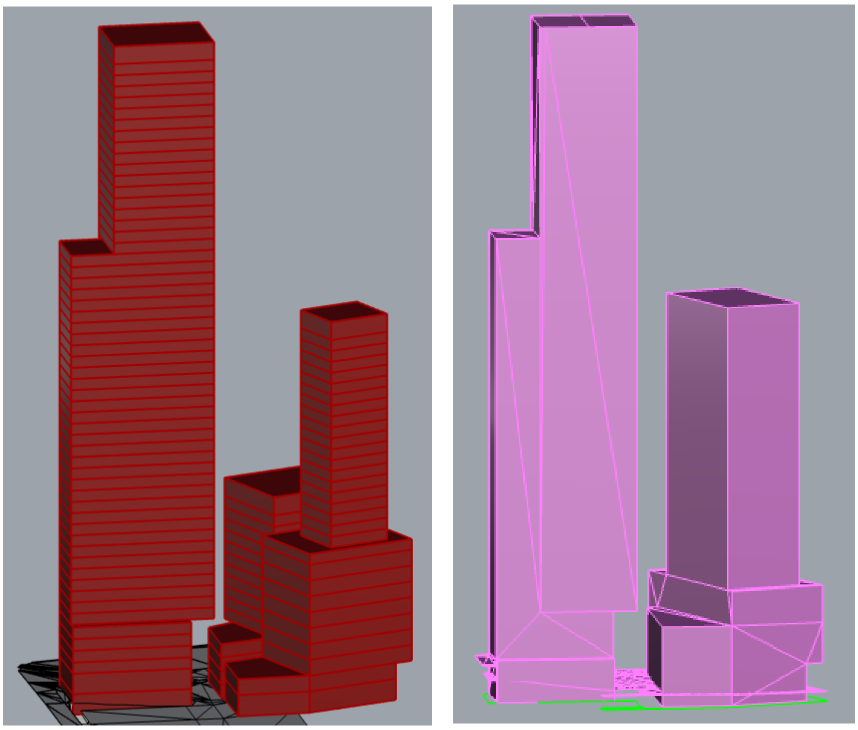

Figure 3: View from the south of existing (L) and proposed (R) development

Sydney Wind Climate

The proposed development lies approximately 10 km to the north of Sydney Airport Bureau of Meteorology anemometer. The wind rose for the airport is shown in Figure 4 and is considered to be representative of prevailing winds at the site. It is evident that the prevailing winds for coastal Sydney come from the north-east, south, and west. Winds from the north-east tend to be summer sea breezes and bring welcome relief on summer days. Winds from the south occur throughout the year and tend to be cold, generally associated with frontal systems that can last several days. Winds from the west are the strongest of the year and are associated with large weather patterns and thunderstorm activity. These winds occur throughout the year and can be cold or warm depending on the inland conditions.

This wind assessment is focused on these prevailing wind directions.

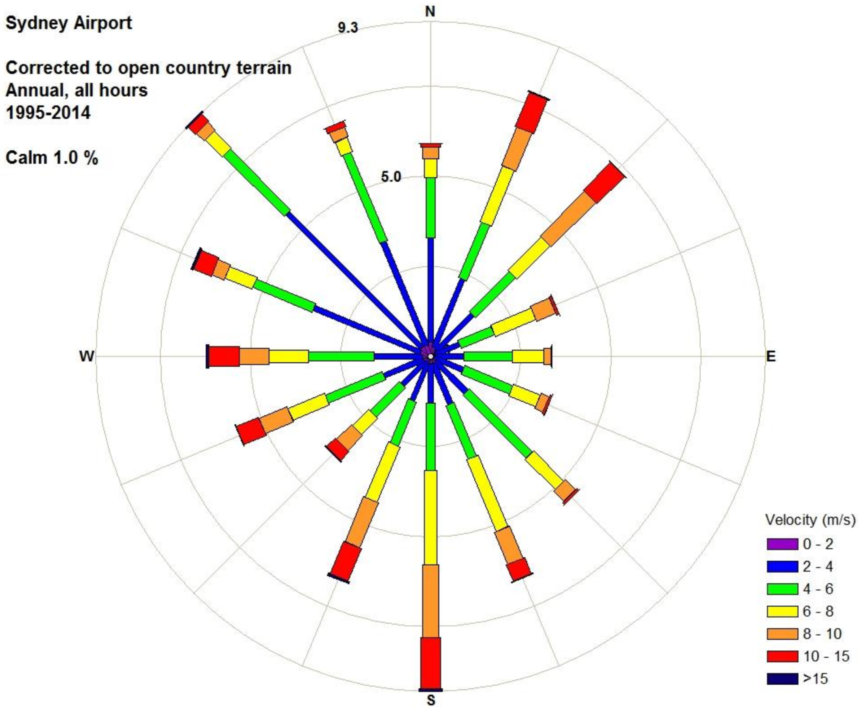

Figure 4: Wind rose for Sydney Airport

Environmental Wind Speed Criteria

It is generally accepted that wind speed and the rate of change of wind velocity are the primary parameters that should be used in the assessment of how wind affects pedestrians. Local wind effects can be assessed with respect to a number of environmental wind speed criteria established by various researchers. Despite the apparent differences in numerical values and assumptions made in their development, it has been found that when these are compared on a probabilistic basis, there is remarkably good agreement.

The current City of Sydney (2012) DCP specifies wind effects not to exceed 10 m/s around the entire block as this is an active frontage. There are few locations in Sydney that would meet the 'active frontage' criterion without significant shielding to improve the wind conditions. From discussions with Council this is a once per annum gust wind speed similar to the wind criteria in City of Sydney 2004 DCP, but is meant to be interpreted as a comfort level criterion to promote outdoor café style activities and is not intended to be used as an upper bound for pedestrian distress requirement. The once per annum gust wind speed criterion used in the City of Sydney (2012) DCP is based on the work of Melbourne (1978), which is for the probability of the gust occurring in an hour of data for 0.1% of the time, or two peak storm events in a year. The 10 m/s level is classified as generally acceptable for pedestrian sitting, and the 16 m/s for pedestrian walking. The Melbourne criterion gives the 'once per annum gust wind speed', and uses this as an estimator of the general conditions at a site. To combat this limitation, as well as the once per annum maximum gust wind speed in an hour, this study is based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. The benefits of these criteria over many in the field are that they use both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations. The criteria based on the mean wind speeds define when the steady component of the wind causes discomfort, whereas the GEM wind speeds define when the wind gusts cause discomfort.

Table 1: Pedestrian comfort criteria for various activities

Comfort (maximum wind speed exceeded 5% of the time)	
<2 m/s	Outdoor dining
2 - 4 m/s	Pedestrian sitting (considered to be of long duration)
4 - 6 m/s	Pedestrian standing (or sitting for a short time or exposure)
6 - 8 m/s	Pedestrian walking
8 - 10 m/s	Business walking (objective walking from A to B or for cycling)
> 10 m/s	Uncomfortable
Distress (maximum wind speed exceeded 0.022% of the time, twice per annum)	
<15 m/s	General access area
15 - 20 m/s	Acceptable only where able bodied people would be expected; no frail people or cyclists expected
>20 m/s	Unacceptable

The wind speed is either a mean wind speed or a gust equivalent mean (GEM) wind speed. The GEM wind speed is equal to the 3 s gust wind speed divided by 1.85.

Wind Flow Mechanisms

When the wind hits an isolated building, the wind is accelerated down and around the windward corners, Figure 5; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward and sides of the building. In Figure 5 smoke is being released into the wind flow to allow the wind speed, turbulence, and direction to be visualised. The image on the left shows smoke being released across the windward face, and the image on the right shows smoke being released into the flow at about third height in the centre of the face.

Techniques to mitigate the effects of downwash winds on pedestrians include the provision of horizontal elements, the most effective being a podium to divert the flow away from pavements and building entrances. Awnings along street frontages perform a similar function and generally, the larger the horizontal element the more effective it will be in diverting the flow.

Channelling occurs when the wind is accelerated between two buildings or along straight streets with buildings on either side.

Figure 5 shows wind is accelerated substantially around the corners of the building. When balconies are located on these corners they are likely to be breezy, and will be used less by the owner due to the regularity of stronger winds. Owners quickly become familiar with when and how to use their balconies. If the corner balconies are deep enough, articulated, or have regular partition privacy fins then local calmer conditions can exist.

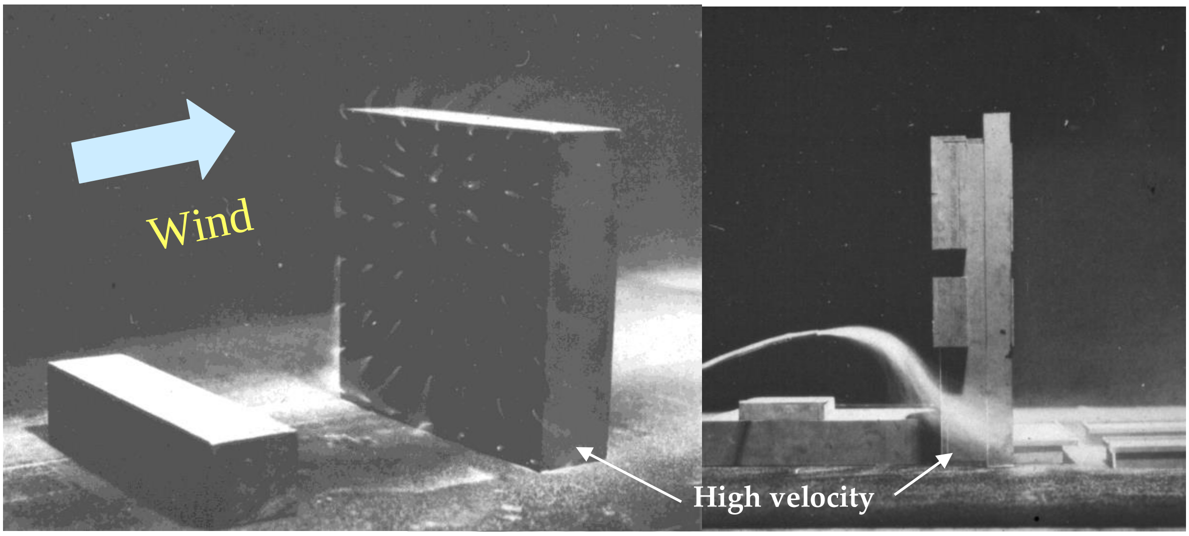

Figure 5: Flow visualisation around a tall building

Previous test results

Wind tunnel testing was carried out for the existing architectural scheme as shown in Figure 6 with the relevant results in Figure 7. More detailed information on the testing can be found in Cermak Peterka Petersen (2010).

The consolidated results from this study are presented in Figure 7 illustrating that the wind conditions around the site are generally classified as acceptable for pedestrian sitting or standing, with localised windy areas between the buildings (Locations 7, 12, and 20 in Figure 7), and to the west of the main tower (Location 16 in Figure 7). These wind conditions are caused by winds from the north-east quadrant. The inclusion of an awning wrapping around the north-west corner of the development improved the comfort wind conditions to being acceptable for pedestrian walking, and still slightly exceeding the distress criterion, Location 16A in Figure 7.

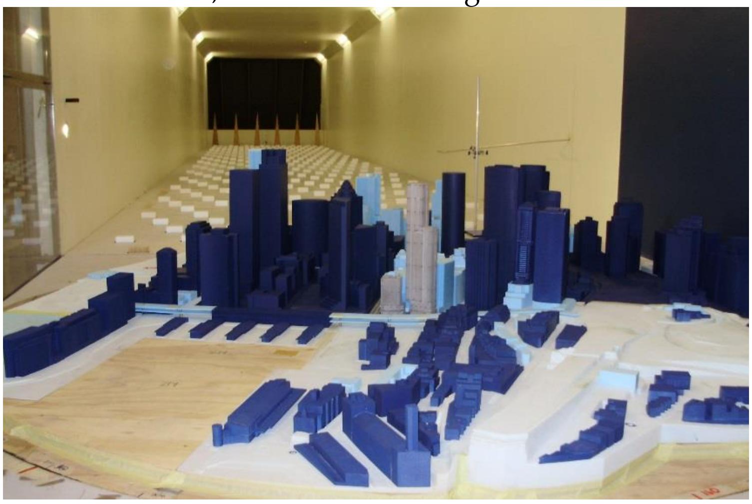

Figure 6: Photograph of the One Alfred Street model in the CPP wind tunnel

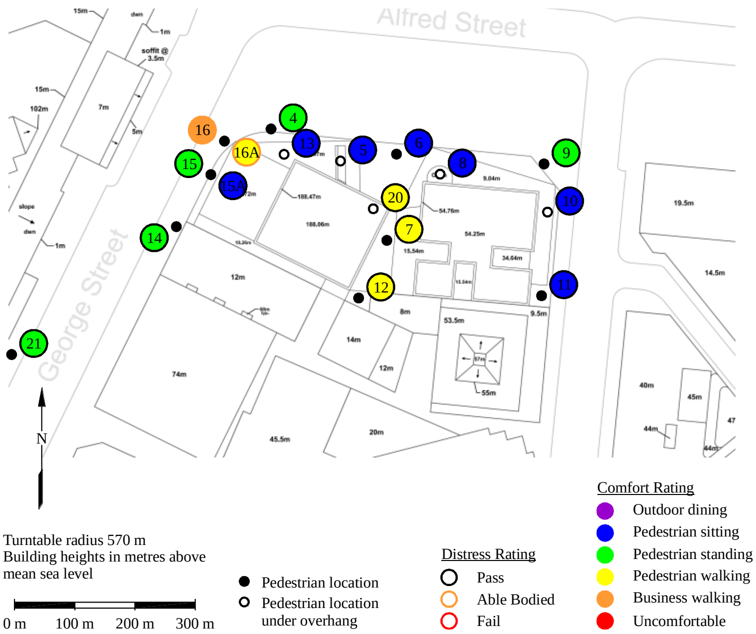

Figure 7: Pedestrian wind speed measurement locations with comfort/distress ratings

Environmental Wind Assessment

With the inclusion of the Fairfax building in this development site, the geometry has been revised to include the additional area. From a wind perspective the major differences between the schemes in Figure 2 and Figure 3 are:

- the north-south dimension of the taller tower has increased by about 3 m,
- the existing Fairfax Building and smaller One Alfred Tower have essentially been enveloped to create a building about 22.6 by 37.5 m in plan and about 110 m tall,
- the north façade of the tall tower has some articulation at the upper tower setback level, and
- the spacing of the pedestrian passageway between the buildings has been enlarged by changes in both the vertical and horizontal directions.

Except locally, these changes are not expected to have a significant impact on the wind conditions measured previously. The site is well protected by surrounding buildings for winds from the south and west quadrants. The inclusion of 200 George Street is expected to further assist in shielding the site for winds from the south. The development site is exposed to winds from the north-east and this is the critical wind direction for this site.

<u>Winds from north-east</u>

For winds from the north-east, the general increase in massing along Alfred Street is expected to induce a greater amount of flow to be directed along Pitt and George Streets. Wind conditions along Pitt Street are complex being generated by the flow interaction between the tall buildings in this part of the City. The wind conditions in the immediate vicinity of the site are expected to be slightly windier than those measured previously, Figure 7, but still classified as acceptable for pedestrian standing or walking and marginally pass the distress criterion.

Wind conditions in the laneway between the buildings is pressure driven, as the two towers are relatively close to one another compared with the east-west dimension. As the development has increased in massing and the laneway area opened with the removal of the small podium, the flow through the laneway is expected to increase. As the previous wind conditions classified this passageway as slightly into the pedestrian walking range, this classification is expected to remain. Any activation of this space for pedestrian sedentary activities such as an outdoor café style would require additional local amelioration in the space such as vertical screens, particularly in the summer months when the north-east winds are prevalent.

The wind conditions around the George Street corner are expected to be slightly windier due to the increased massing along Alfred Street. This flow consists of downwash flow accelerating around the corner. The large awning around the corner, will assist with the wind conditions, but conditions are still expected to marginally exceed the safety criterion as per the previous testing. A solution to this issue would be developed with the design team during detailed design and quantified through a wind-tunnel testing programme. The solution may be as minor as extending or reshaping the awning to the north and west of the development to offer more local protection to pedestrians.

Conclusions

Cermak Peterka Petersen Pty. Ltd. has provided an opinion based assessment of the impact on the surrounding local wind environment of the proposed Sydney 1 development at 1 Alfred Street, Sydney. The change in massing of the building compared with the previous design used for the wind-tunnel testing is expected to slightly increase the local wind speeds along Pitt and George Streets, and in the laneway between the towers for winds from the north-east. It is expected that all areas would be classified as suitable for pedestrian walking or better from a comfort criterion. All locations are expected to pass the distress criterion except on the corner of George Street where it is expected to marginally exceed the criterion. Additional work will be required by the design team to improve the wind conditions for pedestrian safety in this area and quantified through wind-tunnel testing.

References

Cermak Peterka Petersen, (2010), Wind Tunnel Tests for: One Alfred Street, Sydney, October 2010.

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Lawson, T.V., (1990), The determination of the wind environment of a building complex before construction, *Department of Aerospace Engineering, University of Bristol*, Report Number TVL 9025.